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ABSTRACT

This paper begins with a brief review of research trends in the area of organization and memory. A discussion in them presented their relevance to the study of children's processing abilities, and the suggestion is presented of a possible useful tool in the application of knowledge about information processing to the educational experience of the child. While the author's major interest is in the field of learning in handicapped children, it is suggested that young normal children may also benefit from such applications. The measurement tool described is The Sampling Organizational and Recall Through Strategies (S.O.R.T.S.) test. It has been designed to diagnose specific levels of spontaneous grouping strategy generation in such a way as to predict an appropriate educational intervention to enhance the use of conceptual strategies. The procedure for administering and scoring the test is described, in addition to a discussion of test interpretation. (BW/Author)

Measuring Children's Organizational Strategies

by Sampling Overt Groupings *

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Copies of this paper, the S.O.R.T.S. test, and the organizational strategies training sequence mentioned are available by writing to the author at the following address. Please specify which materials are desired: R. Hunt Riegel
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Measuring Children's Organizational Strategies by Sampling Overt Groupings.

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Many inferences derived from adult studies about children's memory abilities have been based on assumptions of quantitative differences due to age. A developmental perspective, however, includes qualitative differences as well, and should be considered more carefully if applied researchers are to make educationally relevant recommendations regarding school curricula. In this paper we shall briefly review research trends in the area of organization and memory, discuss their relevance to the study of children's processing abilities, and suggest a possibly useful tool in the application of knowledge about information processing to the educational experience of the child. While this writer's major interest is in the field of learning in handicapped children, it is suggested that young normal children may also benefit from such applications.

In the field of information processing, a great deal has been written regarding the optimal amount of information manageable at a given time for the purposes of storage. Limits on adult processing abilities have been specified (Miller, 1956) and refined (Mandler, 1967) to suggest that some form of organizational strategy must be activated in order to overcome the demands made on memory by large amounts of information. Kinds of activities related to retention and recall too, have been studied (Tulving, 1968), in which primary and

secondary organization of information has been discussed. Typically, these studies have involved adult subjects, and the factors discussed have related to the relationship between experimenter-imposed material and the subject's recall.

One other variable related to recall which has received much attention recently is the variable described as "clustering" by Bousfield (1953). In studies related to this phenomenon recall protocols have been analysed to determine the consistency with which items recalled appear adjacent to each other over trials. Again, the majority of these studies have been conducted with adult subjects, with generalizations made regarding the nature of memory failing to take into account possible qualitative developmental differences. Modifications of the clustering studies for use with children have been made (cf. Stephens, 1964), but they continue to emphasize recall variables only, holding input presentation constant or under the careful control of the experimenter. It seems to this writer that the study of organizational factors related to learning and retention in children must encompass both developmental trends in organizational processes at input and organizational factors at recall. Further, if educationally relevant recommendations are to be made, the relationship between input and output variables must be better specified. To this end, the study of organizational processing in children, particularly as it relates to conceptual behavior, must be taken into account. To restrict the study of memory and recall-related factors to adult subjects who have already developed organi-

zational schemes for processing information is to ignore the nature of the means by which those schemes developed, and limits our ability to apply knowledge about information processing to learning in the formal educational process.

Much evidence has been presented which suggests that children's organizational schemes differ qualitatively from one developmental stage to the next (cf., Inhelder & Piaget, 1959; Kuhn, 1972), and that the kinds of operations observed at a given time may be analyzed in terms of the underlying conceptual level determining their form. Generally these schemes are seen to change from perceptually determined collections of items to hierarchical groupings. From an information reduction point of view (as espoused by Miller and Mandler) these qualitative changes may be seen as progressing toward higher competence in both organizational effectiveness and related output (recall) efficiency. Unfortunately, studies related to the identification of organizational schemes in children have typically focussed on the type of relations found by children in a set of experimenter-imposed groups. Like the adult studies of recall, and like the modifications of those studies with children, studies of organizational schemes have been limited to only one aspect of the learning for retention process. For example, Bruner and Olver (1963) have obtained a wealth of data regarding age differences in the kinds of relations found between sets of experimenter-imposed items, but have stopped short of collecting recall data relevant to those relations. Kuhn (1972), too, has substantiated in part the stages of grouping behavior specified by Inhelder & Piage (1959), again without pursuing the

question of the effects of the differing grouping schemes on recall. It seems to this writer that such studies, while providing valuable information specific to the questions they are asking, tend to suffer from laboratory 'rigiditis' in that they consistently fail to associate input factors (e.g., classificatory behavior, grouping strategies, transformations) and output factors (e.g., clustering, total recall). We would suggest that the two may be related in operational terms. But before turning to this writer's suggested solution to the above problem, let us briefly consider the learning problems of the young mentally retarded child.

By the age of six years, children entering the mainstream of education are exposed to a wide variety of activities in which information processing and remembering are essential. Often, however, children of this age group have not fully developed cognitive abilities which are precursors to efficient processing skills. For example, the ability to decenter or attend to associations between several stimuli simultaneously is often not fully developed. Many young children will tend to "center" or attend to only one attribute of a single stimulus, and to be attracted more by perceptual characteristics of items than to intrinsic or more functional dimensions (cf. Bruner & Olver, 1963). Functional awareness of their own thought processes, too, is still unavailable for planful learning in most young children (cf. Flavell, Friedrichs & Hoyt, 1970), although there is evidence from several sources that young children do in fact utilize some form of organization, albeit inefficient, in pro-

cessing a set of stimuli (Rossi & Rossi, 1965; Moely, et al., 1969). The kinds of difficulties mentioned above appear to be even more extensive in children identified as mentally retarded.

Retarded children have frequently been described as inefficient learners, although there is evidence that associations, once formed, tend to be fairly durable in these as well as normal children (cf. Baumeister, 1967). Indeed, recall of items from short term memory seems to be within normal ranges for underachievers (cf. Murakawa & Pierce-Jones, 1969). The problems encountered by the retarded are most frequently associated with acquisition phases of learning, and have been related to inefficient learning habits (Osborn, 1960; Iano, 1971) or to poor conceptual skills (Stephens, 1966). Studies investigating the kinds of associations retarded children generate have consistently shown that they identify and use fewer functional relations or more perceptually-based groupings (cf., Stephens, 1966; Stacey & Portnoy, 1951; Spitz, 1966). If such findings are to be related to improving educational practices, instruments must be developed to accurately diagnose the kinds of strategies EMR children employ during acquisition, and to suggest possible intervention programs for improving those strategies.

One such measure is described here. The Sampling Organization and Recall through Strategies (S.O.R.T.S.) test has been designed to diagnose specific levels of spontaneous grouping strategy generation in such a way as to predict an appropriate educational intervention to enhance the use of conceptual strategies.

There are several factors which must be taken into account in the development of an instrument for assessing the organizational abilities of young children. The measure should allow for spontaneity on the part of the subject in selecting grouping strategies. The measure should allow for young children's unfamiliarity with written symbols. A variety of strategies should be tapped in determining the relative ability of a child to group a list of items. Thus items should have the capacity for being grouped along a variety of dimensions. The child should be given an opportunity to understand what is expected of him before definitive statements can be made regarding his ability to generate grouping strategies. The effects of rote rehearsal should be minimized if grouping strategies are to be meaningfully related to recall data. And the effects of novelty of the items on the measure should be minimized, so that confounding recall with degree of original learning may be avoided.

With these factors in mind, the construction of the instrument has taken the following form: (1) Items selected for the test were common animate and inanimate objects for which the child was likely to supply a name. (2) Items were to be presented pictorially to avoid children's inability to read their names. (3) Items have the capacity for a wide variety of associations as well as "straight" categorical relations. (4) A perceptual dimension independent of the item itself was needed to allow for sorting along a color dimension which would not be confounded with other, higher-level sorts. (5) The total number of items in sorts requiring recall

had to be large enough to avoid ceiling effects, yet small enough not to overwhelm the subjects. (6) Instructions were needed which would avoid any cues or reinforcements for particular kinds of sorts, so that subjects would be encouraged to generate <u>his own</u> groups. The test, when constructed with these factors in mind, has thus taken the following form:

1. Administration instructions have been developed which standardize procedures related to stimulus presentation and which specify standard prompting procedures for minimizing unintentional cueing (See Appendix A.).

2. Specific directions for the test, in the form of verbatim instructions for the subject and procedural instructions for the examiner, have been developed for administrative standardization (See Appendix B.).

3. A scoring sheet has been developed for rapid scoring of grouping responses and in which specific information related to the child's sorting performance may be readily recorded (See Appendix C.).

As is evident from the appendices, the test is composed of four distinct parts. In the first, the child is asked simply to put pictures together the way he thinks is best, and to give his reasons for the groups. The instructions are open-ended with the aim of eliciting a relatively pure estimation of what the child does spontaneously in such a situation. The second part is a repetition of the first, but with explicit instructions to search for similarities

between the items. These first two sorts contain only 12 items, and serve not only as diagnostic measures but also as warm-up activities to the more important sort 3. No recall is required, and children seem quite willing to attempt to organize this small set. The third part, however, does require recall, and so includes 20 items. In this sort, the items are changed from animals to common inanimate objects which are known to most children. This shift, along with altering the spatial array of the items at presentation, is intended to reduce the possibility of interference of the first sorts on the recall of the third. Following his grouping and a recall period, the subject is again asked his reasons for the particular groups he made. The fourth part of the test is intended for administration only after the child has made his own groups and recalled from them. In this part, the experimenter arranges the 20 pictures used in the third sort into the categories specified on the scoresheet (i.e., things that grow, things that make noise/music, furniture, transportation, things to live in). He then asks the subject to give the reasons he thinks are appropriate to the groups formed, and again asks for recall. Typically this fourth part has been used only in posttesting in the studies we have run, in order to avoid contaminating the spontaneous generation of groups in earlier sorts. If used as a diagnostic instrument, however, this part should be included in all cases.

In the course of administration, data is collected in the following categories:

1) the actual groups formed by the subject

2) the subject's verbalized reasons for each group he formed.

3) the experimenter's judgment of what the child was doing (should 1 and 2 above be discrepant), and comments regarding unusual events during testing.

4) the verbatim protocol during recall in Sorts 3 and 4.

5) the subjects' reasons generated for categories formed by the experimenter in Sort 4.

In addition to these "hard data" indices, recalled items are then coded according to the groups they were in during the sorting phase, which will then yield an index of clustering, to be discussed below.

Scoring the test:

An extensive review of previous literature concerned with conceptual development and developmental sorting differences (see above), and much field observation, have led the writer to a five-point scoring system which describes the relative level of grouping strategy employed by young children. Specific scoring criteria are reproduced in Appendix D, and describe the kinds of sorts likely to occur, rather than implying values. While it has been found that levels 1 and 2 sorts (syncretic and perceptual) have consistently been related to underachievers, retarded, or very young children, all higher-level associative responses should be devoid of implied judgmental value. Idiosyncratic associations, for example, may be quite different from conventional categorical sorts, yet may have

great mediational value for the individual. Indeed, several writers have cautioned against the fallacious belief that conventional categories are "better" than elaborative contexts or other kinds of rich mediational strategies (cf. Bussis & Chittenden, 1970).

There are basically three scores which are derived for the purpose of describing the child's performance:

(1) the sort level obtained by means of a weighted average of items grouped in particular ways. This index is obtained for each of the four sorts in the test. The level assigned to sort 4, however, is based primarily on the subject's reasons for the groups, since he is not asked to sort the cards in this part.

(2) the actual correct recall of items in Sorts 3 and 4, obtained by simple counting.

(3) an index of clustering, providing a measure of the extent to which recall protocols correspond to the organization present during input. Thus, in Sort 3, the clustering index is derived by comparison of recall order with the groups the child made. On Sort 4, the index is derived by comparing the recall order with the experimenter's groups. A description and rationale for the clustering index chosen will be provided below, in the section entitled "clustering". While these three scores comprise the major informational data for analysis, there are several other factors which are available for study. For example, the total number of groups represented at recall and the average number of words per group at recall are two such factors. For our purposes here, however, we shall limit our discussion to the three major data sources.

1. The weighted average.

In order to assess the way in which a child approaches the problem of sorting an entire array of pictures, an index was developed which would reflect in a single score both the extent to which all items were considered and the relative extent to which inclusion and exclusion rules were used. To this end, a weighted average based on the number of items grouped at each level was devised. The number of pictures the child placed into each group was weighted by the number assigned to the kind of group he formed, according to the specifications in Appendix D. An average score for the entire array was then taken by dividing the sum of the individual group scores by the total number of items in the array. The formula used was $S = \frac{\Sigma(N_j \cdot L_j)}{N}$, where S is the subject's sorting score, N is the total number of items presented, N_j is the number of items in each group, and L is the weight specific to each of the j groups. This index, while losing information about specific groups made, has the advantage of providing a general summary of the child's relative proximity to efficient information-reduction groupings.

2. Recall

Specific items recalled were assigned index markers corresponding to the groups made by the child. These indices were used in an analysis of runs, which constitutes the basis for the clustering score described in the next section. Total recall was counted, ignoring repetitions. Intrusions were treated separately. Analyses of recall were made both in terms of group means and by frequency counts of subjects recalling

more than eight items correctly, those recalling less than four, and subjects recalling between four and eight items. These ranges are based on the short term memory expectations defined by Miller (1956), modified to account for the slightly smaller recall scores (Nelson, 1969) observed in young retarded children. Thus frequency analyses of recall data were made around the expected short term memory range of 6 ± 2.

3. The Clustering Index.

This index, based on runs theory for which statistics have been developed (Mood, 1940) and modified (Wallis & Roberts, 1957), has been adapted for use with recall data by Frankel and Cole (1971). Their paper presents a thorough analysis of the various clustering indices in use, and is recommended for readers interested in this aspect of organizational analysis. Basically, the index derived is a Z - score representing the difference between the observed number of runs of items from j categories and the mean number of runs occurring by chance in a list length of N items with J categories represented, divided by the square root of the variance of the number of runs observed. The formulae used to derive this score may be found in Frankel & Cole's paper, but are reproduced here for the reader's information:

$Z = \dfrac{Or - Mr}{\sqrt{Vr}}$, where Or is the observed number of runs in a given recalled list, Mr is the mean of the normally distributed number of runs for list length N, derived by the formula $Mr = \dfrac{N(N+1) - \Sigma_j N_j^2}{N}$,

and Vr is the variance of the observed number of runs, calculated by the formula $Vr = \frac{\Sigma_j[\Sigma_j N_j^2+N(N+1)] - 2N\Sigma_j N_j^3-N^3}{N^2(N-1)}$.

The benefits of this statistic derive from the fact that it accounts for chance runs in the recall protocol, and is independent of the list length it is used to explain.

With this background in mind, we turn now to two studies conducted by the writer and his colleagues in the Research, Development and Demonstration Center for the Education of Handicapped Children at the University of Minnesota. Both studies involved the use of S.O.R.T.S. as a dependent variable in the training of young handicapped children to generate and utilize more efficient, planful strategies for organizing materials. A sequence of training activities was developed in which skills necessary to the successful utilization of a grouping strategy were systematically taught to the subjects over a month's time. Pre- and post- test analyses were conducted, and change scores were evaluated. The following is a summary of these projects.

Study 1: The St. Paul strategies instructional program

During the summer of 1971 a project was conducted in St. Paul, Minnesota under Title I funding, in which EMR children identified as at least one year below expectation in reading and/or math achievement were provided a program of basic academic training (Riegel & Taylor, 1971). A second component of this project was the development and pilot use of a mnemonic strategies approach to teaching organizational skills. A sequence of activities was developed for use with the youngest third of this population, and the S.O.R.T.S. test

was administered to all children in the project as both a pre- and post-test measure of organization and recall. This administration also constituted the first use of the S.O.R.T.S. test on a large scale

Subjects

The sample of children included in the project ranged in age from 92 to 177 months (7-8 to 14-9 years C.A.). While results of the entire study are interesting and show gains for all age ranges, the older children changed from pretest to posttest primarily in recall and clustering scores. The sorting levels of these children did not charge significantly, due in part to the nature of the training given them. That is, the older groups were trained in the use of elaboration and imagery processes, while the younger children received direct training in grouping and organizational skills. For our purposes in this paper we shall report only the results of the younger groups. Information regarding the older children may be obtained at a later date from the interim report now being completed (Taylor & Riegel, 1972).

The younger group of children were placed in five classes of 10 children each. Data are not available on some of these children due to scheduling and administrative problems, reducing the sample size of this group to 29. The mean chronological age of the group was 110.4 months, with a standard deviation of 9 months. The mean I.Q. was 69.5, with a deviation of 6.25. The mental age of the sample was approximately 77 months, or about 6 1/2 years.

Method

Children were pretested on the S.O.R.T.S. test in late June and posttested in late July, 1971. In the interim, activities were developed and piloted which were designed to improve the child's awareness and use of strategies for seeking relations and organizing sets of stimuli. The tests were individually administered by a group of trained testers. The results were then scored by the writer. A second scorer rescored a later set of data, resulting in an inter-rater reliability on the scoring key (Appendix D) of .94, .89, and .90 for sorts 1-3 respectively. Repeated measures t-tests (Ferguson, 1971) were run to assess the change in overall grouping level over the one month training period. While there were no control subjects available for this study, Study 2 includes such a group for comparison.

Results

Table 1 summarizes the mean pretest and posttest sorting data for the sample, with repeated measures t-test results indicating the significance of the change over one month. As may be seen, the group changed significantly in the direction of using more associative relations in grouping the items ($p < .01$ in all three sorts). Because of the nature of the training, we expected a shift in this direction, and so a one-tailed test of significance was used. In this case and other repeated measures t-tests for this sample, N-1 degrees of freedom were 28, where N is the number of pairs of observation. While the average sorting level increased only about .5 levels on the posttest, this shift indicates that significantly more items were associated

meaningfully by the children than on the pretest.

Insert Table 1 here

Because specific information regarding the kind of sorts obtained is lost through combination of the weighted averages over the entire sample, frequencies of responses at each of three levels of organization are reported in Table 2. Intervals of scores in this table correspond to sorts which are primarily syncretic in nature (A), perceptual (B) or associative (C), indicating a trend from no apparent strategy for grouping to more planful rules for associating items.

Insert Table 2 about here

As may be seen, in the first two sorts, there is a distinct trend from perceptual sorts toward more associative groupings, with seven children more falling in the associative range at posttest. On sort 3, in which the array is significantly larger, the shift is more from a failure to generate an effective grouping strategy on the pretest to sorting at least by perceptual attribute on the posttest, no fewer than 10 children demonstrating this gain. A graphic representation of these shifts is provided in the histogram in Figure 1.

Insert Figure 1 here

It is evident from these data that the children in this sample shifted toward more functional levels of grouping strategies. The recall data shows a corresponding increase in both quantity and clustering quality on the posttest. Given the range of 6 ± 2 discussed earlier as an expected short term store for individual items, we shall present here the frequencies of children falling either within or beyond the limit of 8 items defined by this range. Table 3 presents these frequencies in terms of total number of items recalled correctly on both the pretest and the posttest. The increase of 11 children recalling 9 or more items is a sound indication that indeed the children were recalling more effectively following the training period.

Insert Table 3 about here

The means, standard deviations and significance of these data are summarized in Table 4. A difference of nearly two items recalled on the posttest produces a t of 3.012, significant beyond the .005 level on a one-tailed test with 28 degrees of freedom. On the pretest it may be seen that on the average the children were recalling within the limit postulated for short term store, while the posttest data indicate an average recall beyond that limit. Thus the shift toward more effective strategies is readily evident in the recall data.

Insert Table 4 about here

Clustering of items at recall, too, reflects this shift toward more efficient strategies on the part of the children in the sample, although these data are less dramatic than either the sorting or the recall data. Taking a Z-score of 1.96 as an indication of significant clustering beyond the .05 level, Table 5 summarizes the number of children falling above and below this level. While only 3 children changed in the significance of clustering, a trend toward this index of the use of grouping as a mnemonic strategy may be seen more clearly in the next study, in which the direct association between the grouping operation and remembering was made more explicit.

Insert Table 5 about here

Study 2: The Roseville project.

<u>Subjects</u>

This study, in part a replication of the training sequence study described in Study 1, comprised two "transition" classes of children judged not ready for successful first grade placement. Twenty-nine children were included, but one subject was dropped from the sample due to extreme hyperactivity and behavioral disorders. The mean age of the sample was 78 months, with a standard deviation of 2.7. The mean I.Q. was 100.5, with a standard deviation of 9.4. This sample is younger than that of the previous study, although there is little difference in the average mental age of the two samples (the M.A. in

months of the Study 2 sample being 78 months, and that of Study 1 being 77 months.)

Subjects were randomly assigned within schools to each of two conditions. The experimental groups received training in grouping strategies for 1/2 hour daily for 4 weeks. The control group was given training in art techniques for a comparable amount of time. Pretesting consisted of the first three sorts of the SORTS test, while posttesting included all four parts This study included the first use of the fourth sort in an experimental situation.

Results

The results of pretest and posttest data collected for the two groups are summarized in Table 6. Similarities may be seen between the trend indicated by these data and those of Study 1. The experimental group showed a distinct shift (again of approximately .5 levels) toward more associative groupings, while the control group showed no such change. Repeated measures t tests indicate significant change for the experimental group beyond the .05 level on all three sorts on one-tailed tests with 13 degrees of freedom (N-1 = 13 where N is the number of paired observations).

Insert Table 6 about here

Table 7 presents a frequency of occurance summary of subjects sorting at syncretic (A), perceptual (B) and associative (C) levels. The trend reflected in the above scores is readily evident in the change

in numbers of children sorting at higher levels for the experimental condition, particularly in sorts 1 and 3, in which four subjects moved toward associative grouping from syncretic and perceptual levels on the pretest, while no such shift is seen for the control subjects.

Insert Table 7 about here

In general, it may be said that a proportionately higher number of the experimental group were using associative strategies on the post test than were the control subjects.

The recall data, too, reflects this shift, but in this case the differences in mean scores are not as striking. On the pretest, the control subjects recalled an average of 5.97 items, while the experimental subjects recalled nearly one item fewer (with a mean of 5.0). On the posttest, both groups recalled the same mean number of items (6.6). The differences between the groups is evident in their change scores, however, with a repeated measures t for the control group of 0.785 ($p < .50$), and the experimental group of 2.126 ($p < .05$). Although subjects were randomly assigned to treatments, it was discovered after the training had begun that a disproportionate number of experimental subjects were rated as impulsive on the MFF scale (Kagan, 1965). While only 2 of the 14 control subjects were classified as impulsive, no fewer than 7 of the experimental group were so classified. We take this apparent difference in the groups at pretest to be a partial explanation of the pretest recall differences observed.

Real differences between the groups appear in the breakdown of recall data into subjects recalling more than 8 items, however. Table 8 presents these data, in which it may be seen that, while there was no change in the number of control subjects recalling more than the hypothesized short term limit (there being 3 on both testings), there is a change of six subjects falling in the upper group from the experimental sample.

Insert Table 8 about here

The number of children clustering significantly at recall corresponds to this shift, as summarized in Table 9. While only one control subject changed in the significance with which his recall corresponded to the groups he made on sort 3, four of the experimental subjects showed this shift. This difference provides support for the notion that at least some of the experimental group were learning to use grouping strategies more effectively for remembering.

Insert Table 9 about here

These data, when compared with those of Study 1, lend strong support to the hypothesis that there are systematic changes occurring on the S.O.R.T.S. test in response to training young children to generate and use grouping strategies. One further part of the test should now be considered: the fourth sort, in which children were asked to

discover reasons for and recall items from groups imposed by the experimenter, was administered to both groups at the time of post-testing. The number of children identifying associative or categorical relations for the imposed groups was markedly different for the two groups, as indicated in Table 10. In the control group, there was a tendency to either discover no associative relation at all or to identify the conventional category represented by the items. In the experimental group, however, there was a wider range of responses indicating associative relations, and far fewer subjects who could not identify any functional relations at all (there being only one such subject in this group, and seven in the control group.

Insert Table 10 about here

Differences in the recall averages for each group were larger than those in sort 3, with the experimental group recalling an average of 1.36 items more than the control subjects. The mean recall of the experimental group was 7.64, while the mean of the control group was 6.28. This increase from sort 3 to sort 4 in recall reflects a generally increased ability on the part of the experimental group to utilize organization provided by an external source. A relationship between the subjects' recall and the clustering observed becomes apparent at this point. Six of the 14 experimental subjects recalled 9 or more items from sort 4, while only three of the control subjects recalled in this range. Of the six experimental

subjects, five clustered significantly, while none of the control subjects used the groups provided by the experimenter as significant mnemonic mediators. Table 11 summarizes the mean recall and frequencies of clustering for the two groups.

Insert Table 11 about here

Discussion

The studies reported here are exploratory. Our questions relate to the efficacy of a test for measuring childrens' organizational strategies. While it is suggested that the instrument described is appropriate for the assessment of organizational changes in young children, the training sequence developed for these two studies is but one possible package. In it, the processes involved in the generation of a grouping strategy have been specificed and developed into a sequential progression of processing skills (this sequence of activities is available from the writer, at the address listed on the title page of this paper). Answers to questions related to changes in information processing skills in children are sought through the S.O.R.T.S. test in terms of both qualitative and quantitative indices.

The data reported above reflect the scores obtained on the S.O.R.T.S. test prior to and immediately following a sequence of training activities constructed on the same model. The two studies reported above constitute pilot studies of both the test and the training sequence. As such, it is difficult to make definitive statements about the test

due to the small sample sizes in each study. However, there are strong indications that the children in the samples were performing better in both organizational grouping and recall following training. Although much data is lost by using a weighted average, it is evident that children given organizational training in both studies increased significantly in their use of more associative kinds of strategies (producing a .5 increase in the mean weighted average for both studies). Because the descriptive data fell into groups of scores which were too small for appropriate nonparametric statistical analyses (e.g. - χ^2), we have reported mainly frequency tables. Further studies of the measure currently in progress are using larger samples, and will be more generalizeable. However, even from the small data base available, it is apparent that significant numbers of children are recalling more and grouping more efficiently after even a month of training. It is clear to this writer that the test is a useful one, which is sensitive to the assessment of operational schemes generated by young subjects. It should be specified that this paper does not report data to the end of providing validation information. At this point in its development, the S.O.R.T.S. measure is being used to explore the usefulness of the approach and the kinds of information obtainable. Later studies will attempt to provide indices of validity and reliability for the factors being discussed.

It is also clear that training young handicapped children to organize material improves their ability to deal with large sets of stimuli (20, in this case) planfully, and that such training

facilitates more efficient recall. The data in support of this conclusion are clear; the number of children who did not generate a functional strategy for grouping decrease markedly following training. In Study 1, for example, children in this category descreased from 13 to 2 on sort 3 (Table 2), and from 7 to 2 in Sort 1 of study 2 (Table 7). Children also increased in the use of strategies making use of meaningful associations between items (as opposed to attending to irrelevant color attributes). Sorts 1 and 2 of study 1, for example, show an increase of seven subjects finding associative relations (Table 2) Sorts 1 and 3 of study 2 shows a like increase of four cases employing functional grouping strategies (Table 7).

Recall data, too, are strong indicators of the usefulness of this approach. Study 1 children increased in mean recall by nearly two items (Table 4), with an increase of 11 subjects (more than one third) recalling nine or more. Subjects in the experimental group of study 2 also gained in the number recalling 9 or more items, with six cases (nearly one half) showing this increase. This is contrasted with no change in the control group (Table 8), indicating support for the efficacy of the training sequence. That such changes in recall are accompanied by changes in the grouping strategies employed by the subjects suggests support for our hypothesis that organizational processes at input are related to recall effectiveness. Further support for this hypothesis may be found in the clustering data. Because it is based on the extent of agreement between items grouped at input and items grouped at recall, we take this score to be an

index of the extent to which the groupings formed at input facilitate (and render more efficient) the subject's recall. There are strong indications that in fact such a relationship exists. For example, all but two of the subjects in study 1 who clustered significantly recalled 9 or more items, while the other two recalled 8. All subjects who clustered in study 2 recalled 9 or more items. In spite of the sample sizes and the relatively short intervention period, the trends observed in all three indices are quite strong, and suggest further exploration of the approach.

It would appear from the pilot data on sort 4 that the differences in children's ability to discover and utilize organization imposed on material by the experimenter may be specified. Differences on the kind of associations found in the materials are consistently related to differences in both recall (Table 10) and clustering (Table 11). Children who could identify functional reasons for the groups presented recalled more of the items and clustered them more than those who could not. This finding suggests that training in the use of organizational strategies also facilitates the use (for mnemonic purposes) of organization supplied by an adult. Such a notion would support the concept that organizing teaching may be useful for young EMR children, and that teaching such children how to use the organization supplied would be even more helpful. The results of these studies would support both the efficacy and usefulness of a strategies approach to teaching. It would be possible, if the observed changes in organizational abilities

transfer , for the child to learn material presented in an organized manner more effectively, and to generate a strategy for organizing otherwise unassociated material. Such a possibility, as suggested by these data, would imply much benefit to the consideration of revised curricula incorporating direct training in the use of strategies for learning, rather than the emphasis typically found in special classes on perceptual processing and repetitive presentation of subject-matter content.

From the studies run, the S.O.R.T.S. test is sensitive to changes in organizational skills in children up to a chronological age of 9 years. The promising results of the two pilot studies provide impetus for further testing and the collection of normative data on how young children organize sets of pictures. The information available through this kind of testing may provide us with rich data concerning how children process information. Further, the differences in learning abilities between young EMR and young "normal" children may become more apparent, enhancing the development of more functional cognitive interventions. To date there is a rapidly growing body of subjective evidence from teachers in the classroom and from observations of the writer and his colleagues, that the test has good face validity, and is reliable. Interscorer reliabilities are strong (all in the .89 to .94 range), suggesting that the criteria for assigning scores to the groupings made by the subjects are reasonably objectified. Current studies will include data on reliability between examiners and on test-retest stability.

While there are still numerous problems with the measure to be

accounted for (e.g., the need for an alternate form, for validity measures and the like), our preliminary analyses show it to be a useful tool in the diagnosis of information processing difficulties in young children. It further provides us with a new perspective on the planning and development of educational intervention techniques.

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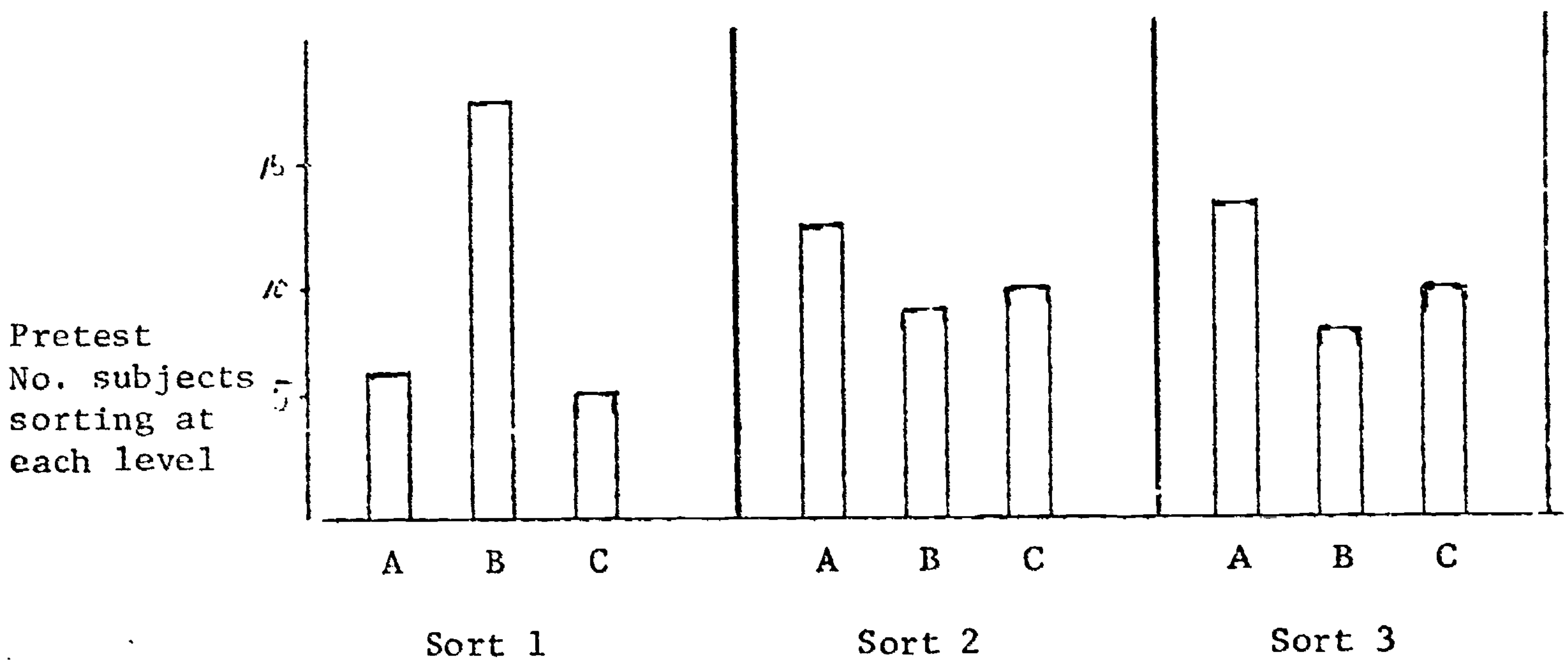
Figure 1

Histogram showing frequencies of scores representing no functional strategy for grouping (A), perceptual groupings (B) and associative groupings (C) for pre- and post-test data, Sorts 1-3.



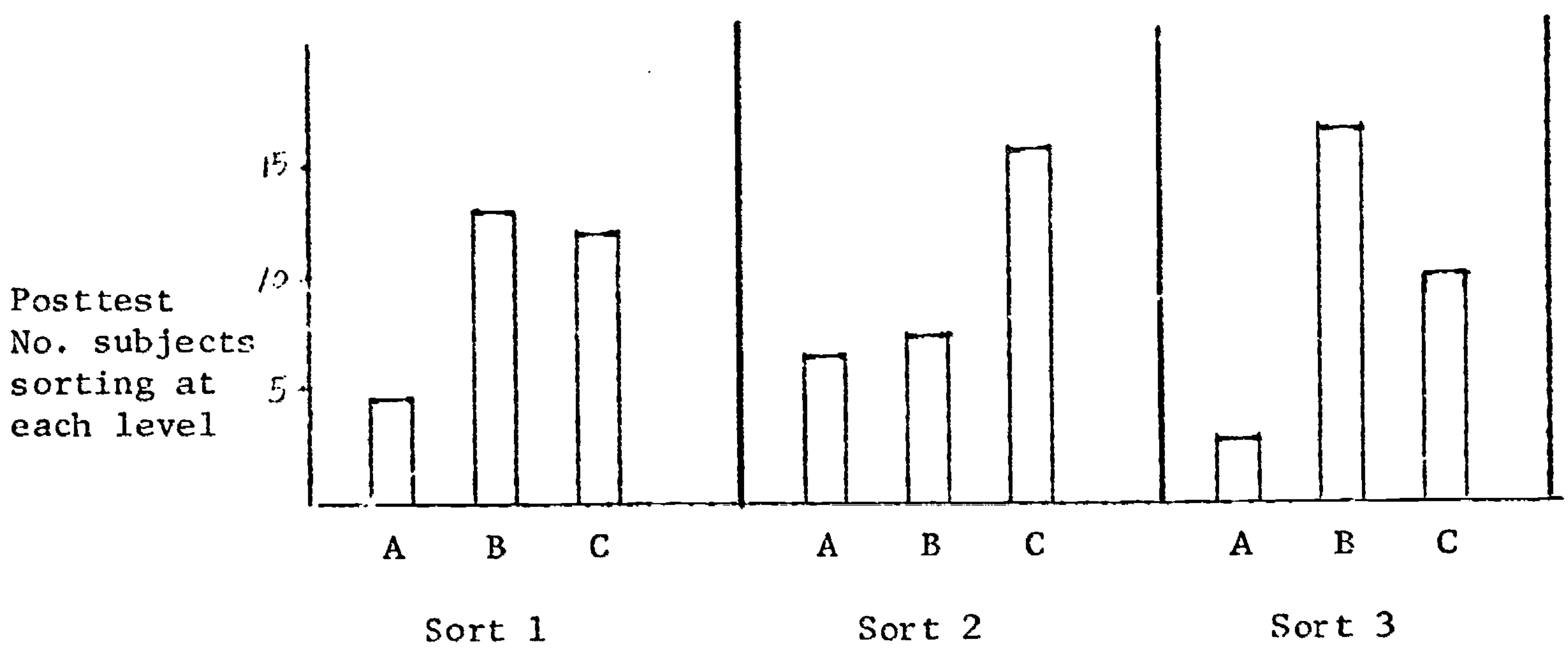


Table 1

Means, standard deviations and t scores for pretest and posttest data; sorts 1 - 3.

		Sort 1	Sort 2	Sort 3
Pretest	$\overline{X}$	1.971	2.106	1.952
	(sd)	(.657	(1.099)	(.925)
Posttest	$\overline{X}$	2.538	2.672	2.397
	(sd)	(1.048)	(1.227)	(.706)
	t	3.348	2.590	2.474
	(28 d.f.)	($p < .005$)	($p < .01$)	($p < .01$)

Table 2

Frequencies of subjects showing no functional strategy (A), perceptual groupings (B) and associative groupings (C) for sorts 1 - 3.

	Sort 1			Sort 2			Sort 3		
	A	B	C	A	B	C	A	B	C
Pretest	6	18	5	12	8	9	13	7	9
Posttest	4	13	12	6	7	16	2	17	10

Table 3

Subjects recalling a. each level; sort 3.

No. of items recalled		Pretest	Posttest
	0 - 8	24	13
	9 - 20	5	16

Table 4

Means, standard deviations and t scores for recall data; sort 3.

	Pretest	Posttest
Recall $\overline{X}$	6.621	8.552
(sd)	(3.029)	(2.923)
t	3.012	
(28 d.f.)	($p < .005$)	

Table 5

Frequency of clustering at .05 level

($Z > 1.96$)

	Pretest	Posttest
No clustering	25	22
Clustering	4	7

Table 6

Study 2 means, standard deviations and t scores for experimental (E) and control (C) subjects; sorts 1 - 3.

	Sort 1		Sort 2		Sort 3	
	E	C	E	C	E	C
Pretest $\overline{X}$	1.673	1.643	1.922	1.482	1.754	1.461
(sd)	(.499)	(.676)	(.770)	(.476)	(.608)	(.511)
Posttest $\overline{X}$	2.451	1.774	2.310	1.566	2.354	1.418
(sd)	(.877)	(.651)	(.873)	(.828)	(1.078)	(.471)
t	4.073	1.095	2.270	.358	2.148	-.279
(13 d.f.)	($p < .001$)	n.s.	($p < .025$)	n.s.	($p < .05$)	n.s.

Table 7

Study 2 frequencies for E and C groups showing no functional strategy (A), perceptual groupings (B) and associative groupings (C); sorts 1 - 3.

		Sort 1		Sort 2		Sort 3	
		E	C	E	C	E	C
Pretest	A	7	7	5	7	4	8
	B	6	5	7	7	9	6
	C	1	2	2	0	1	0
Posttest	A	2	5	3	9	4	9
	B	7	8	7	4	5	5
	C	5	1	4	1	5	0

Table 8

Study 2 subjects recalling at each level; sort 3.

	Experimental group	Control group
Pretest no. of items recalled		
0 - 8	14	11
9 - 20	0	3
Posttest items recalled		
0 - 8	8	11
9 - 20	6	3

Table 9

Study 2 frequency of clustering beyond .05 level of significance; sort 3.

	Exper.	Control
Pretest no clustering	14	13
Clustering	0	1
Posttest no clustering	10	12
Clustering	4	2

Table 10

Study 2 subjects identifying no relations (A), perceptual relations (B) and associative relations (C) between items in experimenter-imposed groups.

	Experimental group	Control group
A	1	7
B	3	0
C	10	7

Table 11

Study 2 recall and clustering in sort 4
for experimental and control groups.

		Experimental	Control
Recall	$\bar{X}$	7.64	6.28
	(sd)	(4.16)	(3.29)
No clustering		8	11
Clustering		6	3

APPENDIX A

SORTS Administration

1. Order -- The first and second sorts involve manipulation of the same set of stimulus cards. The third sort requires a different set. The cards are numbered onthe back for order of presentation, and should be sequenced numerically for each administration. Thus the cards for sort 1 whould be reordered prior to presentation for the second sort. The cards used in sort 3 are again used in sort 4, but the experimenter sorts them instead of the child.

2. Array -- Sorts 1 and 2 are to be arranged in a circle, with each numbered card placed in its corresponding position on the fact of a clock. That is, card #1 (alligator) goes in the 1:00 o'clock position from the child's perspective, card #2 in the 2 o'clock position, and so on clockwise to 12.

   The third, or test, sort is arranged in four rows of five cards each, moving from left to right and from top to bottom. Sort 4 is arranged by E in five rows of four cards each, corresponding to the categories specified on the scoring sheet.

3. Seating -- The experimenter should sit at a right angle to the subject, with his scoring sheet on a clipboard. The scoring sheet should not be visible to the child, although its contents are not meant to be a secret should an inquisitive child ask. Stimulus cards which are not currently in use should be out of the subject's sight.

4. Familiarity -- Prior to administration of the SORTS, the experimenter should have memorized the matrices for recording specific groups. He should know which color group corresponds to which row on the matrix and which category corresponds to which column.

Memorization of the specific instructional protocol is essential, as well as facility with alternative directions.

5. Prompting -- (A). Names. Should a subject not be able to name a stimulus card, the experimenter should supply the name and have the subject repeat that name before the next card is displayed.

If the subject gives a name for a card which also applies to another of the stimulus cards, the name should be corrected, and the subject should repeat the corrected name. Example: if 'owl' is called 'bird', the experimenter should say, "Let's call this an 'owl'. What is this?" (Subject response: 'owl'). Thus the experimenter must insure that no two stimulus cards in the same sort are given the same name.

Inappropriate Names (such as 'cat' for lion or 'dragon' for alligator) are admissible, but should be noted in the matrix beside the corresponding name.

(B). Sorts. One (and only one) prompt is allowable in demonstrating what is meant by putting things together in piles. This should be used only if it is evident that the subject does not understand what he is to do. It should be done only with the duck (card #3) and only on the first sort. And it should be done in the following way: Allow 15

seconds for scanning before determining that the subject will not group the cards. If he still doesn't seem to understand, prompt:

Move the duck to the right of the configuration and say: "See this picture? See if you can find some other ones that go with it."

Again, this may be done only on the above conditions.

(C). Reasons. If the reasons a child gives for his groupings are so ambiguous as to give little insight into his meaning, say: "Tell me more about that." Example situations: initial reason is 'they're the same", "they look alike", or "they go together."

6. Clinical Latitude -- Reared number 4 above concerning familiarity. It is suggested that the directions be given verbatim, but modification of the wording is permissible at the experimenter's discretion in eliciting individual children's grouping responses. Rapport with the subject should be established prior to the beginning of the test rather than during the testing situation.

APPENDIX B

Directions

The tester should read the previous section entitled "Aministration" before giving this test. Knowledge of the procedures specified therein is essential to the standard administration of this instrument.

SORT 1

1. Record child's name, age and sex on the score sheet. Record your name and the date.
2. OK, ________, WE'RE GOING TO PLAY A GAME WITH SOME PICTURES. FIRST, WOULD YOU TELL ME THE NAMES OF THESE PICTURES AS I PUT THEM DOWN? Place pictures in order clockwise from 1 o'clock. Do not overlap pictures.
3. NOW, LOOK AT THESE PICTURES AND PUT THEM TOGETHER IN PILES THE WAY YOU THINK IS BEST. YOU MAY PUT AS MANY IN EACH PILE AS YOU LIKE. WHEN YOU FINISH, I WILL ASK YOU ABOUT THE PILES YOU MAKE. Allow 15 seconds to determine whether the duck prompt is needed. If it is, follow directions on prompting carefully.
4. Record groupings. When grouping has been completed, ask in order of formation:

   WHY DID YOU PUT THESE PICTURES TOGETHER? Record each response. Repeat for each group made by the subject. End of Sort 1. Be sure information is complete for this sort.

SORT 2

1. OK -- NOW LET'S LOOK AT THOSE PICTURES AGAIN. Put out second deck in identical clockwise array.
2. LAST TIME YOU PUT THESE PICTURES IN PILES ONE WAY, AND I ASKED YOU ABOUT THE PILES. THIS TIME, PUT THE PICTURES TOGETHER THAT YOU THINK ARE THE SAME. PUT THE ONES THAT ARE ALIKE TOGETHER IN PILES. Record groupings as in #4 above. Ask for and record reasons for each group made.

SORT 3

1. ALL RIGHT, ______, NOW LET'S LOOK AT SOME OTHER PICTURES. WOULD YOU TELL ME THE NAMES OF THESE AS I PUT THEM DOWN? Place pictures in order, left-to-right, five in each row. The first row should be the farthest from he child.

2. THIS TIME, PUT THE PICTURES TOGETHER IN PILES SO YOU CAN REMEMBER THEM. AFTER YOU FINISH PUTTING THEM TOGETHER I WILL COVER THEM UP AND SEE IF YOU CAN REMEMBER THEM. NOW PUT THEM TOGETHER THE WAY YOU THINK IS BEST. Record the groupings as in previous sorts; if possible, while the child is sorting.

3. Cover groups with cardboard, without mixing them.

4. NOW TELL ME THE NAMES OF AS MANY PICTURES AS YOU CAN REMEMBER. Write every response in order during recall, even if it is a repetition or intrusion.

5. NOW LET'S LOOK AT YOUR PILES AGAIN. Uncover groups, find first group made, and ask:

   CAN YOU TELL ME WHY YOU PUT THESE PICTURES TOGETHER? Record response, and repeat for each group made. **End of Sort 3.** Be sure all information is complete.

SORT 4

1. Pick up the cards used in Sort 3, reordering into categorical groups in the order they are listed on on the scoresheet, page 3: (i.e., grow, noise, furniture, transportation, houses). Order of cards within groups may vary, but the order of the groups in the array may not.

2. WATCH ME AS I PUT THE PICTURES TOGETHER IN PILES A DIFFERENT WAY.

   HERE IS THE ______, THE ______, THE ______, AND THE ______. THAT IS ONE PILE.

   NEXT IS THE ______, THE ______, THE ______, AND THE ______. THAT'S ANOTHER PILE.

   NOW THE ______, THE ______, THE ______, AND THE ______. THAT'S ANOTHER PILE.

   (continue until all five groups have been placed.)

SORT 4 cont.

3. CAN YOU THINK OF WHY I PUT THESE PICTURES TOGETHER? Indicate first group. Repeat for each of the five groups. Write the child's response to each question.

4. When all five groups have been completed, cover the array of pictures as in Sort 3.

NOW TELL ME THE NAMES OF AS MANY OF THE PICTURES AS YOU CAN REMEMBER FROM THE GROUPS I JUST MADE.

Record recall as in Sort 3. End of test.

Be sure that all relevant information for each sort is included on the scoresheet before beginning the testing with the next child.

APPENDIX C
S.O.R.T.S. SCORING SHEET

Name ______________________

Age ________ M / F Date: ______________

Examiner ______________________

Sort 1

	(land)	(water)	(air)
(red)	DOG ________	ALLIGATOR ________	BIRD ________
(white)	COW ________	FISH ________	TURKEY ________
(blue)	SQUIRREL ________	SEAL ________	OWL ________
(yellow)	LION ________	FROG ________	DUCK ________

Reasons:

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________

Comments:

Centering?	Syncretic?	Post-hoc reasons?	Difficulty understanding?
Y / N	Y / N	Y / N	Y / N

Sort 2

	(land)	(water)	(air)
(red)	DOG ________	ALLIGATOR ________	BIRD ________
(white)	COW ________	FISH ________	TURKEY ________
(blue)	SQUIRREL ________	SEAL ________	OWL ________
(yellow)	LION ________	FROG ________	DUCK ________

Reasons:

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________

Comments:

Centering?	Syncretic?	Post-hoc reasons?	Difficulty understanding?
Y / N	Y / N	Y / N	Y / N

 NAME ______________________

Sort 3

	(grow)	(noise)	(furniture)	(transportation)	(abodes)
(red)	FLOWER ______	HORN ______	DESK ______	BOAT ______	TEEPEE ______
(white)	LEAF ______	WHISTLE ______	TABLE ______	PLANE ______	BIRDHOUSE ______
(blue)	BANANA ______	DRUM ______	CHAIR ______	BUS ______	BARN ______
(yellow)	CORN ______	BELL ______	BED ______	BIKE ______	HOUSE ______

Recall: (include all responses in order)

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.

Reasons:

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________

Comments:

Centering? Y/ N

Syncretic? Y / N

Post-hoc reasons? Y / N

Difficulty understanding? Y / N

S.O.R.T.S. Scoring Sheet: Page 3 NAME ______________________________

Reasons for constrained (experimenter's groups:

1. (grow) ______________________________
2. (noise) ______________________________
3. (furniture) ______________________________
4. (vehicles) ______________________________
5. (habitats) ______________________________

RECALL #2:

1. ____________	11. ____________
2. ____________	12. ____________
3. ____________	13. ____________
4. ____________	14. ____________
5. ____________	15. ____________
6. ____________	16. ____________
7. ____________	17. ____________
8. ____________	18. ____________
9. ____________	19. ____________
10. ____________	20. ____________

Comments:

APPENDIX D

S.O.R.T.S. CODING KEY

In scoring the sorts made by children, the following criteria for assigning levels to each group are to be followed. Each group made is to be coded with two numbers: the first number corresponds to the codel level appropriate to the type of sort the child made, and the second number indicates the number of items the child put into that group.

Thus, if the child put three red animals together in one group, and gave as a reason, "because they're the same color", his coded score for that group would be 2 3 (the 2 indicating a level 2, or perceptual group, and the 3 indicating three items in the group).

Three factors must be taken into account in determining the level for each group:

1) the actual group made, indicated by the numbers in the sorting matrix.
2) the reason given by the child for that particular group,
3) the examiner's judgment as to the child's reasons, as indicated in his marking of syncretic or post-hoc reasons, and in his written comments, if different from the child's stated reasons.

Genearlly, should a discrepancy arise between these three factors, greater weight is given to the combination of the S's actual group and the E's judgments, rather than relying on possibly imprecise verbal reports of the S.

The numbers in the column on the left of the page indicate the level to be assigned items in groups corresponding to reasons based on the criteria specified in the text on the right. In case of a clear discrepancy of more than one level on any given group, which cannot be resolved by a specifiable criterion on the coding key, a compromise to the level between the two levels which are discrepant is appropriate. But this composmise should be noted for subsequent interrater discussion.

S.O.R.T.S. CODING KEY

LEVELS

1 No strategy apparent (syncretic)

1 all cards in one or two groups, with no reasons

1 Cards grouped by spatial contiguity

1 Made design (e.g., put cards in form of letter E)

1 Inferred no strategy, based on far-fetched reasons and lack of correspondence with actual group made (often this is the case with post-hoc reasons)

1 Sort based on color differences

2 Sort based on color similarities

2 Sort based on phonetic similarities

2 Sort based on shape of card

2 Dysjunction, either related or unrelated, but treated separately, as in centering (e.g., "this one has _______, and this one has ______")

2 Postural: they are both sitting.

2 Shape of the item (e.g., they are both long)

3 Edge matching each item to the one next to it by association, but with no association for the group as a whole.

3 They have __(noun)__ (e.g., legs, mouth, etc.)

3 They __(verb)__ (e.g., fly, walk, etc.) IN PAIRS.

3 Overinclusive groups (e.g., 8 items in group called 'animals')

3 Multiple groupings: "these two in water, these two swim," but with no connection between groups.

3 Idiosyncratic associations: (e.g., drum with teepee, bicycle with bell, birdhouse with leaf...)

3 They could be (pets, toys, etc..., implying idiosyncratic label).

3 Two items by location with one dysjunctive (inappropriate) in a group of three items (e.g., these two are in the jungle, and there is also a seal)

4 Key ring: several items go together because they are all associated with one item within the group (e.g., 'these go in the house')

4 Association by location IN PAIRS (if identificatory)

4 Association by function IN PAIRS

4 Categorical group, but including one or two items which don't fit the category

4 They (verb), with THREE OR MORE in group

4 They are made of (material), (if appropriate).

5 Association by location (excepting key rings), with three or more items in the group.

5 Association by function, with THREE OR MORE in group

5 Categorization (e.g., these are furniture)

5 They are (label) (e.g., food), even by pairs.

END